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South Dakota Farm and Home Research

South Dakota State University

South Dakota Farm & Home RESEARCH

A CHRONICLE OF BIOSTRESS RESEARCH

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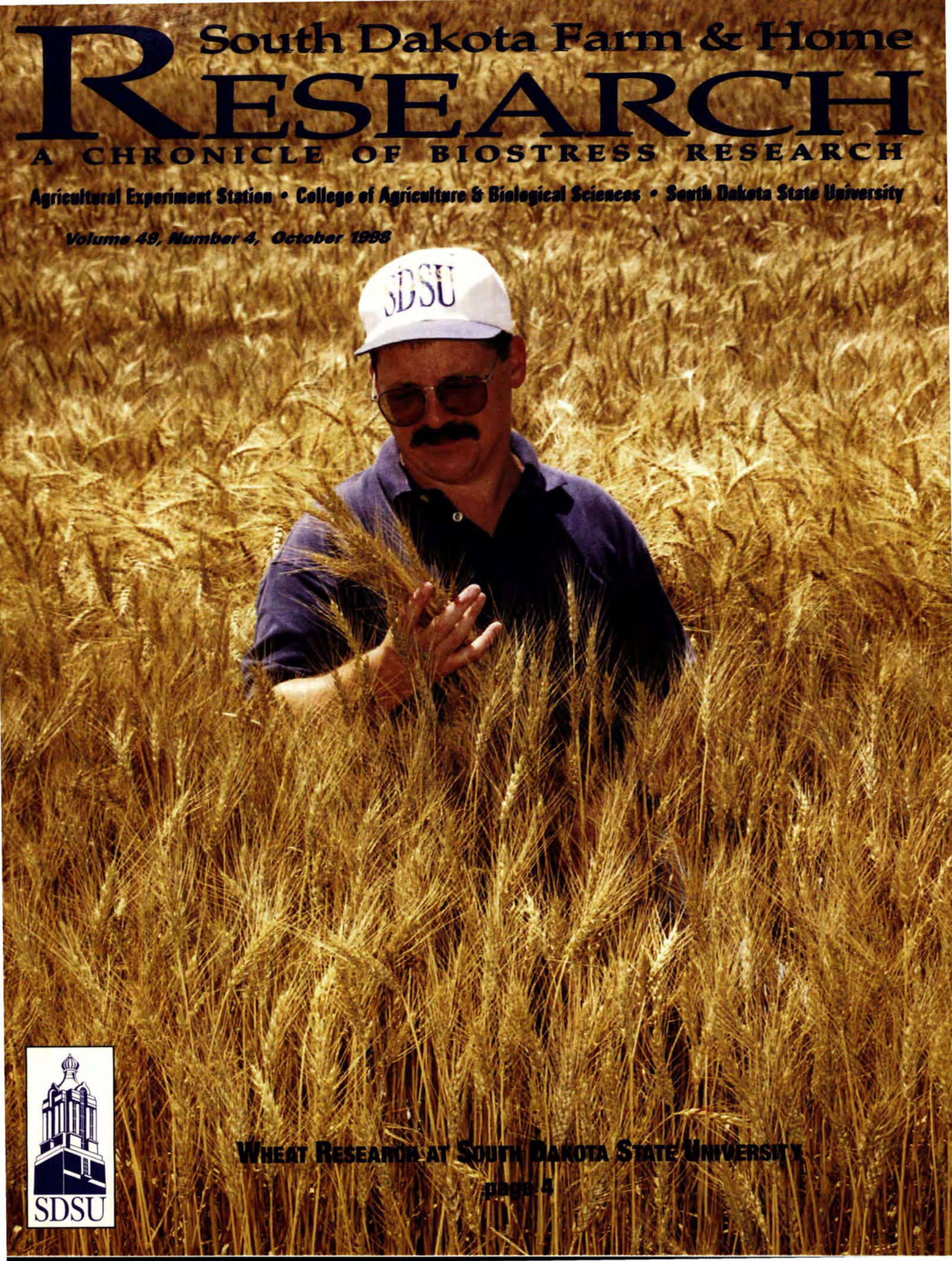

SDSU

WHEAT RESEARCH AT SOUTH DAKOTA STATE UNIVERSITY

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Kephart named acting associate director of Agricultural Experiment Station

Kevin Kephart, professor of plant science and forage researcher and teacher, has been named acting associate dean of the College of Agriculture and Biological Sciences and acting associate director of the South Dakota Agricultural Experiment Station at SDSU.

Kephart is assisting Fred Cholick, who recently became dean of the College of Agriculture and Biological Sciences.

Kephart has been on the SDSU faculty 12 years. He was chosen this year by SDSU students as the Plant Science Teacher of the Year. His research has focused on crop physiology, and he has developed a program that emphasizes forage quality for ruminants.

He and Steve Schiller, SDSU physicist, broke new ground in assessing nutritive quality of standing crops, including grasses, using solar reflectance. They were able to determine the mix of warm- and cool-season grasses in a pasture, for example.

Kephart has developed successful calibration equations which allow NIRS (Near Infrared Reflectance Spectrascopy) analysis for protein, fiber, digestibility, and stress in soybeans, corn, whole oats, wheat, and forage grass seeds. Previously, NIRS was primarily confined to forage analysis.

For the last 2 years, he has been co-coordinator of the SDSU Bolivia Project, a technology-sharing arrangement with a sister university in the Andes of Bolivia. He has traveled to Bolivia several times to help establish programs similar to those of land-grant universities in the U.S.

Kephart has served as associate editor for the international research publication, *Agronomy Journal*. He also serves on the board of directors of the Crop Science Society of America and is the national chairman of the division for crop quality of that organization.

He grew up in the Flathead Valley near Kalispell, Mont., and earned degrees from Montana State University and the University of Wyoming and a Ph.D. in crop production and physiology from Iowa State University. ❖

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About the Cover

Scott Haley is building a winter wheat program with intent to make it sustainable for decades, which involves a certain amount of futuristic thinking and educated guesses. He suspects that, while yield is now the primary criterion in the breeding program, in 10 to 15 years quality will move up in importance. "Our challenge is to put yield and quality together" in breeding new wheats.

photo: Tom Bare

Two constants: change itself and our College mandate

Director's comments

Left to right, Kevin Kephart, Sandy Rusten, and Fred Cholick

by Fred Cholick

It's been four months now, and have you noticed the difference?

I'd be willing to bet not. Instead of following the changes in our College of Agriculture and Biological Sciences administration, you've been watching more important things–the crops, the weather, the markets, the election news, the new things happening on mainstreet of your home town.

Another reason you wouldn't notice is that the three-part mandate of the College is unchanging. We teach, conduct research, and extend knowledge through Extension. We serve people, agriculture, and science.

That is our constant, no matter who runs the ship. The other constant is that things **will** happen, that change **will** occur.

That comes as no surprise, surely. We all find it a little more difficult each year to bend down and lace our shoes. The early morning aches last a little longer into the day. The kids grow up, leave home. A pest mutates, just a little, and becomes resistant to an insecticide that had worked before.

I'm not sure what we at the Agricultural Experiment Station could do about your morning aches and pains. Some of our projects in foods might show you how to touch the floor a little easier. Certainly, our economists, sociologists, and plant and animal scientists are working hard on value-added commodities and technologies which might encourage your children to stay in South Dakota to earn a good living. Some of that work is reported in this issue of *Farm & Home Research.*

Our College mandate doesn't change; our Experiment Station mission–to improve the quality of life in South Dakota–has remained ever constant; what **has** changed over the years is the greater complexity of knowledge uncovered by our researchers. Changing just as rapidly is our understanding of this knowledge on our lives.

I have talked many times about the development of knowledge, the need to transfer it to others in the scientific community, to students, and to the citizens of South Dakota, the people we serve. Now, because of change, somebody else will be writing this column next time you see the magazine.

I have moved to the office next door, accepting the position of dean of the College of Agriculture and Biological Sciences. I have named Kevin Kephart, forage researcher, as acting associate director of the Experiment Station; the Station's secretary, Sandy Rusten, is extremely capable and is carrying on; and our scientists are being very understanding and cooperative during this transition period. To have me away from Experiment Station headquarters is no big change for them; I have traveled far and often while carrying out my duties as director.

I have enjoyed my 4 years as Experiment Station director. The days presented many challenges and many opportunities. I have enjoyed meeting many of you face to face.

Do you see that changing?

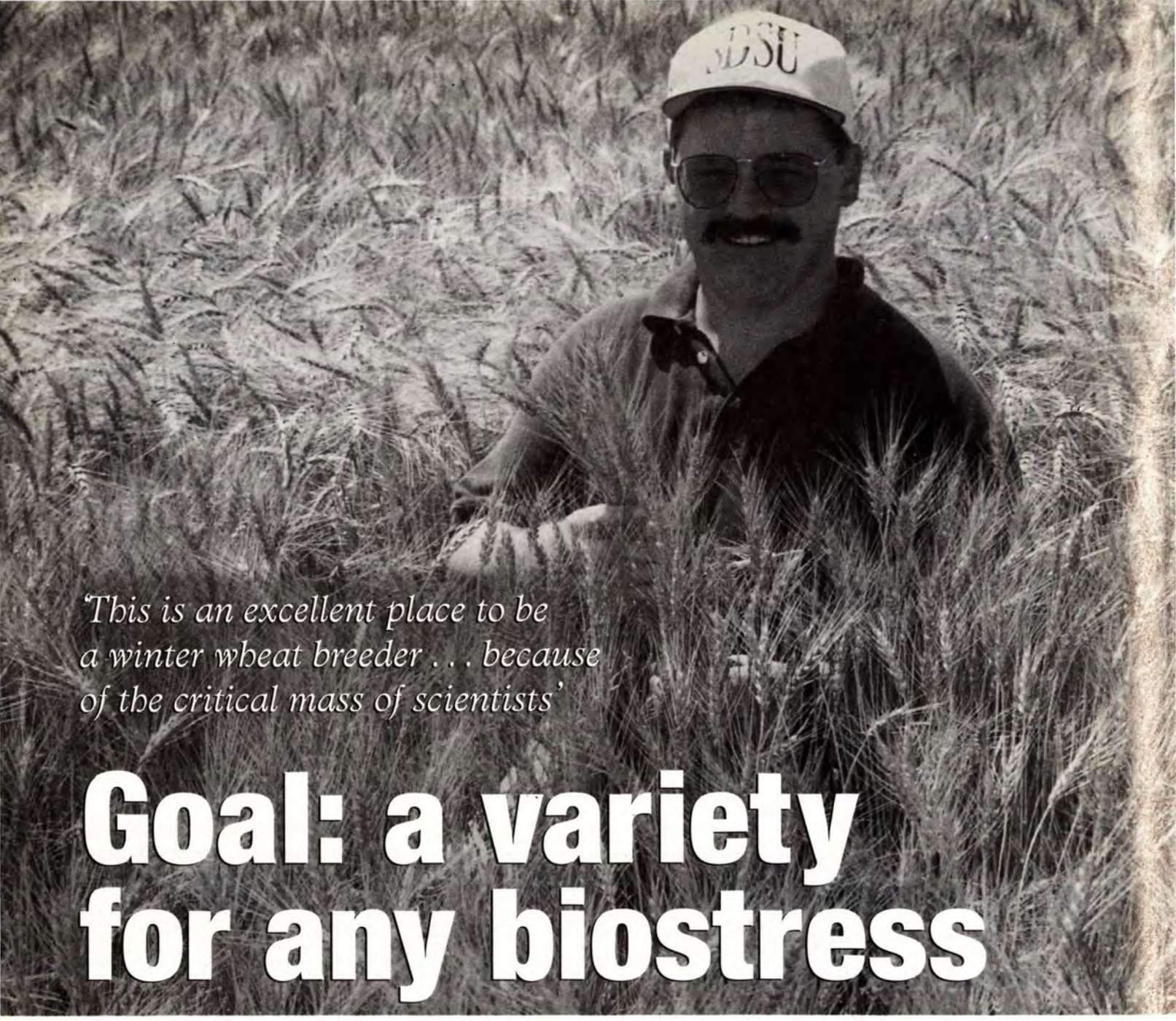
I don't, except that the intensity of challenge and opportunity will be even higher. You hold the key to our success; you define the direction of our research and you apply our results to your own lives. The change I face is that I am now also ultimately responsible for academic and Extension activity. I couldn't ask for better directors of these programs in Gene Arnold, academics, and Larry Tidemann, interim Extension director.

I'd like to end on this note: Be willing to ask the questions.

What are we doing for you and South Dakota agriculture? How are we doing it? Should we be doing it? Can we do it better, whether it is research, teaching, Extension, or analytical service functions here at SDSU, at our outlying experiment farms, in our county offices?

Asking doesn't mean that there is something wrong. It means that you are using your own discernment and expertise to help us, other South Dakotans, and yourselves to change, to grow, develop, and achieve the highest possible quality of life in South Dakota.

Thank you. ❖



'This is an excellent place to be a winter wheat breeder . . . because of the critical mass of scientists'

Goal: a variety for any biostress

by Jerry Leslie

Scott Haley

With one eye on the present and the other on the future, Scott Haley as team leader has brought SDSU's winter wheat breeding program onto a productive and promising track for South Dakota producers during his 5 years at SDSU.

Haley is building the foundation of the SDSU wheat breeding program with intent to make it sustainable for decades.

At the same time, he wants to address the immediate needs of South Dakota producers who have had few varieties to choose from in the last 20 years.

SDSU had not had a winter wheat release since the "barbershop quartet" release of Rose, Dawn, Rita, and Nell in 1980 and 1981. Now, the Ag Experiment Station has put five new varieties in the hands of South Dakota growers–three of them in cooperation with the University of Nebraska.

The first was Nekota, a Nebraska-SDSU release, in 1994. Nekota became an immediate hit with South Dakota producers who planted it this year on about a fourth of winter wheat acres statewide.

The next two were Pronghorn in 1995 and Windstar in 1996, also with the University of Nebraska. In the fall of 1997, SDSU released Tandem and Crimson. A sixth variety is scheduled for release this fall.

In wheat breeding, addressing producer needs means looking far ahead.

Haley said that time involved in developing a new variety from making the first cross to actual release to producers may be 10 to 12 years. That means a breeder must be thinking about producer needs 10 to 15 years down the road.

"I wish I had a crystal ball that would tell me our production systems and quality requirements, so I will not be looking at this 10 or 15 years from now wishing I had done this or that."

Haley has had to make some educated guesses and has turned the breeding program in those directions:

• **Hard white winter wheat variety development**. These varieties can put South Dakota growers in both defensive and offensive positions in the marketing game.

On the defensive side, South Dakota producers would be better prepared to compete with growers in the Southern Plains, in case hard red winter wheats should ever be discounted in the market place.

On the offensive side, a battery of these varieties will prepare South Dakota producers for potentially expanding market opportunities in the Pacific Rim nations now buying more white wheats for noodles. And, as Americans become more health conscious and consume more fiber, whole wheat breads from white wheat may be more attractive to them than brown breads.

To jump start the white wheat program, Haley sought help from Kansas State University and the USDA program at the University of Nebraska. He got more than 100 advanced breeding lines for SDSU use and evaluation.

• **Improved milling and baking qualities**. Yield has been the primary selection criterion in the breeding program. However, Haley suspects that in 10 to 15 years, quality will be more important than it is today and that buyers, if not rewarding higher quality, may penalize growers for poor quality. Haley and others have seen signs pointing in this direction.

"Quality is at least partially under genetic control and is certainly in the domain of the breeder," Haley said. "So our challenge is to put yield and quality together."

• **Improved disease resistance**. "We have been working quite a bit on disease resistance the last few years. Wheat streak mosaic virus tolerance is coming closer to reality. In collaboration with Marie Langham, SDSU research virologist, we've developed useful screening procedures for wheat streak mosaic tolerance.

"We have two lines on increase with intent to release next fall that have significantly better tolerance to wheat streak mosaic than varieties currently available. They have done well and have good baking quality, tan spot resistance, and rust resistance–good disease resistance with good winter hardiness," said Haley.

Haley also has collaborated with Yue Jin, research pathologist, to expand greenhouse and field screening activities for stem rust resistance.

"As we change our wheat from red to white we need to make sure we maintain the stem rust resistance we have built up over the last 20 to 25 years," Haley said.

• **Varieties for no-till and high-yield production systems.** "More and more winter wheat producers are planting back into some kind of protective cover. Their requirements are definitely changing to varieties with higher yield potential but less winter hardiness."

Related to this are the structure of the plant and increased resistance to leaf spotting disease. No-tilled and heavily fertilized plants need better straw strength, shorter height, and earlier maturity.

"We're seeing some producers becoming much more aggressive in how they manage winter wheat. Our conventional winter-hardy, tall, late-maturing plant types may not be well adapted for them," said Haley.

Serious lodging can occur from a combination of high soil fertility, high planting rates, increased moisture from no-till systems, and tall, late-maturing wheat varieties developed for traditional fallow systems.

"I and others feel no-till will be a greater part of our production system 10 to 15 years down the road. In this area, we're not there yet, but we're making progress. Breeding is a continual process that requires patience and a realization that quick results don't always come."

• **Herbicide-resistant wheat varieties**. A major chemical company has made winter wheat germplasm that is resistant to the IMI (imidazolinone) class of herbicides such as Pursuit available to SDSU. This would hopefully allow breeders to develop varieties that will allow producers to use that herbicide for grass weed control, such as for jointed goatgrass which is becoming a problem.

• **Aphid-tolerant wheat.** Tom Cheesbrough, molecular biologist in the Department of Biology/Microbiology, has been working on transferring a gene for a proteinase inhibitor from potato into wheat. "It would potentially be effective for aphid control. I eagerly await the first results of that research," said Haley.

Producers have seen quick results from the Haley team and will see more soon.

This fall, Haley hopes the Ag Experiment Station will release, in cooperation with the USDA Agricultural Research Service program at Lincoln, a line more adapted to no-till production but different from recent releases from Kansas in that it has good stem rust resistance. The as-yet-unnamed variety was tested as N95L158.

Two other lines are on increase for potential release in fall 1999. They have tolerance to wheat streak mosaic and other diseases and good winter hardiness. They have been tested as SD92107 and SD93267.

One of these two was the top performer in South Dakota variety trials in 1996 and 1997, years when winter hardiness was important. It did less well after the mild winter of 1998 when varieties that were more winter-hardy were less competitive.

Haley also has two experimental lines in preliminary foundation seed increase on 3 to 5 acres. The earliest possible release on either of these is the fall of the year 2000.

"The common thread contributing to success of plant breeding programs is continuity. Over the last 5 years we've built a solid foundation for the program. The most important part is not that we've released varieties. The most important part is that we've built a foundation for the next 10 to 15 years that can only build on itself.

"Much of that can be attributed to the financial support of the South Dakota Wheat Commission and the seed trade industry through the South Dakota Crop Improvement Association and Foundation Seedstocks Division," Haley said.

"This is an excellent place to be a winter wheat breeder because we have other plant scientists, particularly in the area of pathology. This is a good situation for breeding for disease resistance," Haley said, "because of the critical mass of scientists."

Plant breeding is a team effort. Haley's immediate group is made up of Steve Kalsbeck and Rich Little and two graduate assistants. Based in West River is Clair Stymiest, Extension agronomist.

With more than 10,000 winter wheat test plots over seven sites in South Dakota, cooperators become invaluable to the breeding effort. Besides SDSU-operated plots, Haley has two private cooperators, Mark Stiegelmeier of Selby and Brian Jorgensen of Winner, each providing several acres for test plots.

Stiegelmeier was chairman of the Walworth County Crop Improvement Association at a time when it was interested in getting a winter wheat test plot started in the county. He set aside some of his own land for a plot.

"It gives me an opportunity to see how the varieties do in my own farming situation and I get to visit with Scott and learn what's coming," Stiegelmeier said.

"We've been real supportive of what SDSU is doing in trying to advance variety development."

Stiegelmeier planted Crimson, one of Haley's new releases, on a Foundation Seed increase this last year, and is presently selling registered seed from that increase.

Stiegelmeier believes in using producer checkoff dollars for wheat research. "I think it is very positive. If we want new and better varieties, I guess we need to have a part in it. If we are supporting it, they'll have the funds to be able to work, advance, and bring new varieties out."

Steigelmeier said he likes to see Haley coming out to the field to see what's happening out there. "He gets to know South Dakota conditions, which are very diverse across the state, and learns what he has to do to bring out varieties that are adapted to the diverse parts of South Dakota.

"I think we are going to see some progress in the winter wheat breeding program in South Dakota with Haley at the helm." ❖

"It [research] gives me an opportunity to see how the varieties do in my own farming situation and I get to visit with Scott and learn what's coming .... If we want new and better varieties, I guess we need to have a part in [research]."

—Mark Steigelmeier, Selby, winter wheat producer

Biostress challenge:
developing winter wheats to meet producer needs decades down the road

Wetlands with grassed buffers are economically and environmentally sound parts of a farming plan

The benefits of a buffer

by Mary Brashier

Larry Janssen

Ask folks on the street and they'll say that wetlands are beneficial and should be protected.

Ask farmers who have wetlands on their land, and they'll probably agree–grudgingly.

Their reluctance is hardly a surprise to anyone, including researchers who conducted a poll of farmers last fall.

"What showed up," said Larry Janssen, SDSU economist, "was that most of them appreciated the benefits their wetlands provide, even if those benefits go to someone downstream.

"Naturally, they were much more concerned about the very real financial costs to themselves of keeping up these wetlands.

"And why not? They are the ones who lose the income those areas of the field might have provided and who have to maneuver their machinery around the wet areas."

But they can regain some of that lost income, Janssen said.

Budget sheets he has compiled show that "buffered" wetlands are both environmentally beneficial and economically competitive.

Buffers are vegetative strips, seeded to pasture grasses and native plants, around the wetlands. SDSU researchers have opted to work with a 75-foot buffer.

"It looks like fields with buffered wetlands, even if the buffers result in a somewhat smaller acreage for crops, have slightly higher average yields per acre over the entire field," Janssen said. "The economics for the field tend to even out and the environment is protected at the same time."

The research on buffers is the natural sequel to more traditional wetlands research at SDSU.

"Over the years we have gathered a pile of evidence about the value of wetlands to farmers and society at large," said Diane Rickerl, plant scientist.

"Many people–scientists, economists, sociologists, wildlife specialists, microbiologists, geographers, and most important of all, farmers–have contributed to the research.

"We all learned–or reinforced what we already knew–that wetlands are good for wildlife, water storage, and environmental cleansing.

"But we also knew we wouldn't get very far if we simply walked up and said to a farmer, 'why don't you quit farming this wetland because there are a lot of ducks that want to live here?'

"The poll confirmed that it was time to pass on what we've learned to landowners, so we are turning from research to acquire knowledge to demonstration projects to extend knowledge–showing how to make wetlands more financially valuable to farmers," Rickerl said.

"We'll keep track of the ducks, but the focus is now 'how do I keep on farming and get almost equal income from the field by protecting the wetland?'"

The farmer survey, conducted jointly by Janssen and Randall Rogers of the Rural Sociology Department at DakotaFest and State Fair in 1997, indicated that farmers were more in agreement with each other about the costs of wetlands than they were about the benefits.

Farmers indicated that their greatest problem with wetlands was that they were a source of weeds for adjoining fields. Inability to plant or harvest, reduced yields, and the time to work around rather than through the wetland were also highly important.

Ranked lower, but still "neutral" to "important" on the scale with one exception, were the benefits. Farmers tended to put groundwater replenishment as the top environmental advantage, but scattered their responses for

other listed benefits, which included erosion control, hunting and recreation, and water quality improvement.

They checked "unimportant" for forage production from the wetland.

The responses were an eye opener to Rickerl. She convinced her class in water quality in agriculture to build a gazebo overlooking one of Charlie Johnson's wetlands in Lake County as a service project. They stocked it with educational materials and made it the hub of wetlands tours for farmers and other interested groups.

A similar gazebo was erected at another research site on Oak Lake in northeastern Brookings County.

As a community service project, SDSU students in a water quality class built a gazebo to house wetland educational materials.

Twelve wetlands in Lake County have been under study since 1995 by the research team, with buffer strips circling eight of them. Soil, water, and plants are analyzed for nutrient content, and economic budgets are compared for four different wetland management plans (from "farming through" to 75-foot buffers), three farming systems (conventional, no-till, and organic), and three crop price and yield levels (baseline and 10% above and below).

Net returns from fields with buffered wetlands are similar to or slightly lower than net returns from maximum crop production for the average (baseline) price and yield scenario.

"Higher crop prices and yields would favor crop production and unbuffered wetlands," Janssen summarized.

"But during a low-price period, buffered wetland production is far superior to any management plan, provided the wetland is enrolled in the Wetland Reserve Program (WRP) with a haying option."

Net return to management was 88, 44, and 1% more in the WRP scenario than in the no-buffer plan for a transitional no-till, conventional, and organic system, respectively.

What is a wetland?

Farmers in the poll had difficulty defining "wetland," and sometimes it truly is hard to identify. To say that water must be present for a certain number of days may not be a good criterion. Most scientists rely on the presence of **hydric soils** (which have developed under wet conditions and tend to hold and retain water during at least part of the growing season during normal years) and **hydrophytes** (plants that can tolerate saturated soils and/or standing water for extended periods). During an extended drought period, hydrophytes may not be present, but if hydric soils are present, the area is a wetland. When wet years return, hydrophyte seeds will germinate and grow again.

Temporary wetlands pond water for brief periods during the growing season.

Seasonal wetlands are usually ponded through June or later.

Semipermanent wetlands hold water through the year, most years.

Permanent wetlands typically hold water throughout the year every year.

(From: Berry, C.R. and D.G. Buechler, *Wetlands in the Northern Great Plains*; and Johnson, R.R., K.F. Higgins, M.L. Kjellsen, and C.R. Elliott, *Eastern South Dakota Wetlands*, two publications prepared by and available from SDSU Department of Wildlife and Fisheries Sciences, Box 2140B, SDSU, Brookings, SD 57007.)

"Income is higher in every case."

WRP is like CRP, except that the key difference is that the wetland is enrolled for a minimum 30 years. A management plan is jointly agreed on; there will be permanent cover and no draining or filling. Haying is optional. In some cases, grass establishment is cost shared.

Haying the buffer strip brings benefits into the farmer's livestock operation, Rickerl said.

"The buffer acts as a filter," she said, "trapping the first wave of nitrates and orthophosphates that arrives in silt or runoff water. The grasses in the wetland receive an extra shot of fertilizer, the hay crop is more nutritious, and the farmer gets another chance to use the fertilizers that otherwise would be unavailable." (See table).

The haying option is something Charlie Johnson, host farmer for many of the research sites, wishes he had.

He put his largest wetland, some 20 to 30 acres, and accompanying upland into the federal water bank program in the early 1990s. There was no haying option offered at the time. Johnson thinks that was a weakness of the program.

"Total protection of grassland just isn't the way nature works," he said. "Either buffalo graze it or fire burns it. In the last year or two, I can see the grasses in this buffer suffering a little; they're getting sod bound.

"Our 10-year contract is up in a year or two. We'll do something different then–maybe fence off a smaller buffer area and the slough and put the rest into permanent pasture."

All of Johnson's buffers, which he has also installed around a group of four or five temporary wetlands, are squared off and often larger than the 75-foot-wide strips Rickerl used. The temporaries are in no federal program and Johnson takes off an annual hay crop.

"A lot of it is marginal ground anyway," Johnson said of land surrounding his wetlands. "The crop yields weren't all that great and strips just didn't really lend themselves to good use of the machinery.

"We just squared them off so we'd have decent-shaped fields on the other side of the fence."

The multidisciplinary wetlands project wraps up in December. Over the years it has been funded from the Ag Experiment Station, Sustainable Agriculture Research and Education, national research initiative competitive grants program for farming systems, and ACE (Agriculture in Concert with the Environment, which is an EPA/USDA joint fund).

"Ultimately, it points out that buffer strips are an excellent management scheme for producers both economically and environmentally," Rickerl said, "especially if combined with a haying option in WRP.

Diane Rickerl, center, led a farmer tour of a buffered wetland.

"Farmers own the wetland resources, but society wants them to be protected, and through WRP, society pays for them to take care of the wetlands. Yes, the question of interference with private property rights comes up.

"But the program **is** voluntary."

Johnson agrees, from both land stewardship and practical viewpoints, about the value of protecting wetlands.

"I have no real way of putting a figure on it, but I think we're coming out ahead. Wetlands are a hydrological sponge that keeps the water around in drier years, and in every year they are a filter for any kind of environmental contaminant out there.

"A lot of the enormous amount of flooding the state's had in the last 10 to 15 years is because we've had excessive drainage in the previous 50 years. It'd be nice if we could go back 100 years and start over with what we know now." ❖

Buffer strips are environmentally effective. About half of the plant nutrients were taken up by buffer plants rather than wetland plants.

Buffered wetlands:	*Nonbuffered wetlands:*
99 lb/A N in buffer plants 82 lb/A N in wetland plants	173 lb/A N in wetland plants
13 lb/A P in buffer plants 9 lb/A P in wetland plants	24 lb/A P in wetland plants

Nutrients removed by the buffer could be used as hay instead of being lost from agricultural production.

Biostress challenge:
farming less acres, earning the same or often more

'This is basic research with a purpose, science for the people'

And the walls came a-tumblin' down

by Jerry Leslie

Walls separating several departments in the College of Agriculture and Biological Sciences at SDSU have fallen in response to the need for shared resources and knowledge.

These walls were not brick and mortar; they were administrative. Now researchers from various backgrounds and in different disciplines are cooperating in solving multi-faceted problems.

This approach to research relates better to actual South Dakota conditions and problems and has resulted in improved efficiency, say those who work with it.

The idea of crossing department lines originated in the 1980s with Dennis Nelson, who as Veterinary Science (VetSci) department head was trying to fill staffing needs.

He needed a research immunologist but couldn't justify a full-time position. Meanwhile, Charles McMullen in Biology-Microbiology (Bio/Micro) had to find a 9-month teaching immunologist.

Nelson offered to fund a 3-month research appointment to enhance the 9-month teaching position, and together he and McMullen offered the job to a top-ranked immunologist from Pennsylvania State University, David Hurley.

Bio/Micro has moved on to also fill basic bioscience research needs for other departments–Plant Science, Animal and Range Sciences, Dairy Science, and Wildlife and Fisheries Sciences–while continuing to perform its traditional classroom teaching role. "We were a department that in the old days was looked at strictly as a teaching department," McMullen said.

Today the department receives considerable funding from several crop and livestock commodity groups for research. A few years ago it received none.

"We are now looked at as an important component of the ABS College in both teaching and research and we are looked upon to provide answers and data to help solve problems of South Dakota," McMullen said.

It took support from the college central administration to convert 100% teaching appointments to teaching-research positions, McMullen stressed. "Collaboration is looked on with favor all the way up the line to the regental level," McMullen said.

This kind of collaboration is fairly unique. "I don't think you will find anywhere in the country a land-grant university where the bioscience department has as close connections with production agriculture as at SDSU."

The new flexibility naturally led to the formation of interdisciplinary teams to solve specific problems. There is, for example, an animal infectious disease research team with members from VetSci, Bio/Micro, and Dairy Science. This is basic research with a purpose, science for the people.

Researchers are encouraged to go out in the field, said one of the scientists. Appearing in Extension type workshops with producers and veterinarians, they can stay alert to emerging animal disease and vaccine effectiveness.

Chris Chase, VetSci researcher, conducts a part-time practice at Flandreau which continues to give him insights into the needs of private veterinarians and their farm clientele. He shares that insight with his fellow scientists.

And Raymond Rowland, virologist and immunologist, is a classroom teacher in Bio/Micro 9 months of the year and a veterinary researcher 2 months. Sharing makes him and his colleagues more efficient, he said, integrating research, service, and teaching.

"It's the best use of knowledge. We're just recognizing people's expertise. It's getting the job done.

"In fact I share a lab in the Biostress Lab with Tom Cheesebrough, molecular biologist. He works on soybeans and I work on PRRS (porcine reproductive and respiratory syndrome)."

Rowland emphasized how students benefit.

"We encourage students in their first year of college to participate in research. This does several things for

When somebody in the lab says, "hey, come look at this," students researchers, staff, and senior scientists gather around. They are (left to right) Ann Sperlich, junior from Parkston; Mellisa Steffen, lab technician; Tom Cheesebrough, mircobiologist; Bob Rowland, virologist; Ryan Gruber, junior from Sauk Rapids, Minn.; Ellen Holmberg, junior from Centerville.

them. It exposes them to techniques they do not learn in the classroom.

"Many of these students come out of college with 2 or 3 years of practical job experience, and most important, it teaches these kids how to think. In addition, students develop job opportunities through the industrial contacts of veterinary science researchers," said Rowland.

Other benefits from the new alliances and team approaches:

The faculty can make fullest use of knowledge, buildings, laboratories, and equipment. New researchers find a base of operations to build their reputations. By opening the door to the "real world," researchers are better able to concentrate their research on the important and current needs of farmers and ranchers.

Graduate students become skilled in the use of equipment and facilities and can broaden their contacts with faculty members and research ideas from other disciplines.

Clientele, stakeholders, people in South Dakota who rely on SDSU for services and educating their students are better served.

Commodity groups and taxpayers receive greater return for the dollars invested in SDSU research.

"I don't know of anyone who doesn't benefit from this arrangement," said McMullen.

Collaboration has brought national recognition to SDSU and its scientists. New, unproven, young staff members come in, are helped to secure competitive research grants, and then build their reputations.

Hurley said he had no national ranking as an investigator when he came to SDSU and needed to move into an established group to provide a base of funding. At SDSU he found the team of David Benfield, David Francis, and Mike Hildreth. "The first month, I walked in and wrote an Integrated Pest Management grant on Benfield's and Francis' reputation, Mike Hildreth's interest in parasitology, and my interest in immunology.

"The grant was funded. I got a student, a research assistantship." The department helped equip his lab.

Then, when Chase came aboard, Benfield, Francis, and Hurley helped him in the same manner.

In addition to helping younger scientists build a name for themselves, "it's been quite effective in bringing people into projects we can support–projects relevant to the state–by offering material, labor, space, and intellectual support," Hurley added.

The networking relationship between VetSci and Bio/Micro became the model for the cross-discipline concept in the planning of the regional Northern Plains Biostress Laboratory where research is undertaken from at least five academic departments involved in life sciences. New research teams will form as South Dakota-based problems arise and need solving. ❖

Biostress challenge:
collaborating to solve South Dakota-based problems

Field Days

by Tom Bare

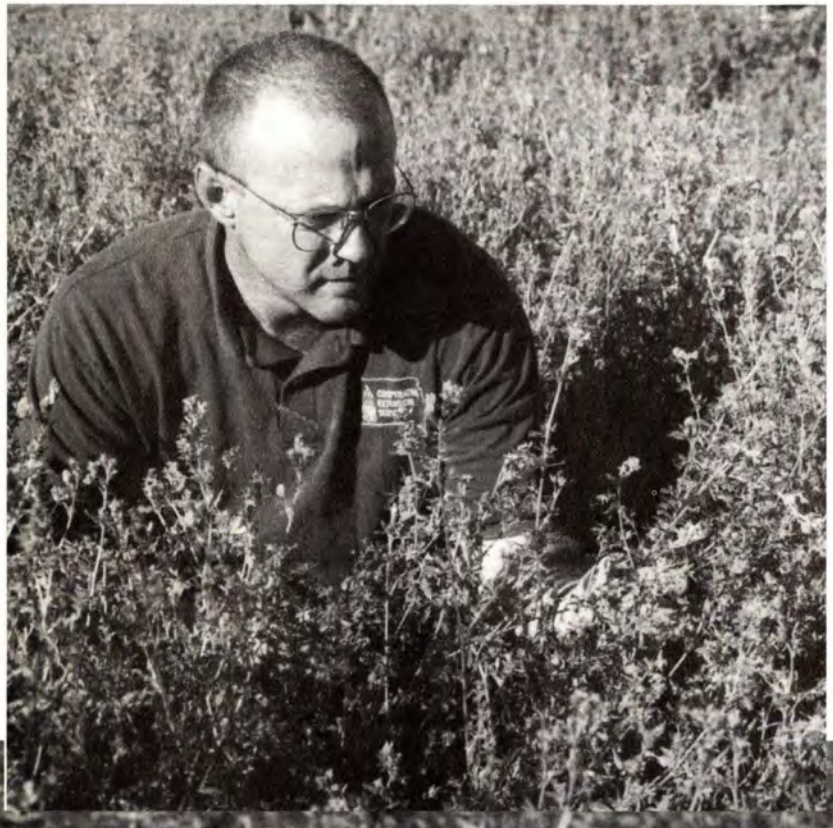
Many SDSU agricultural scientists "go on the road" every summer to pass their knowledge on to people who will use those results.

At field days held at the Ag Experiment Station's six out-state research farms, they explain, in practical terms, how their work contributes to South Dakota agriculture. This page, top, at Antelope Range, Don Marshall ties genetic markers to cattle production traits and, at the Northeast Farm, Mike Catangui discusses Bt corns and western corn rootworm flights.

Facing page, clockwise from top, Bob Hall shows off side-by-side wheat varieties, Dwayne Beck describes the no-till air seeder at Dakota Lakes Research Farm and shows the results–no-till soybeans planted into corn stalks. Vance Owens says that 10% bloom seen from the side of the field is already past prime and proposes a simple method to estimate quality in the standing crop.

These presenters, and the many others who fanned out from Brookings to field days around the state this summer, are rarely "pure" researchers. Most, in fact, have a combination of research, Extension, and teaching appointments. Catangui and Vance are Cooperative Extension scientists but agree with the others that the mission of the College is to develop knowledge and offer it to the people who need it.

Field days are over for the year; but visit any of the research farms at any time, and watch for next year's "open houses."



The quality of rural life—how much is it worth?

Turnaround

by Larry Tennyson

South Dakota and much of the Upper Midwest lost population to other states throughout most of the past 40 years, but the trend began an about-face during the 1990s, according to Bill Adamson, SDSU economist, and Mark Partridge of St. Cloud (Minnesota) State University.

The two are exploring why non-metropolitan areas and small metropolitan cities are gaining in population and large central cities are losing population.

Since the 1960s, the entire U.S. labor market has undergone profound changes, according to Adamson. After 1973, growth in real wages for most Americans slowed dramatically and declined outright for many low-skilled workers. The gap widened even more during the '80s.

Wages for educated, highly skilled workers are proportionally lower in rural areas than for less educated, less highly skilled workers; so, in theory, migration trends should reflect a higher percentage of net loss of better educated workers from the rural areas.

But during the 1990s, South Dakota followed the national trend and gained population through net in-migration, "although most of it has been concentrated in the larger communities such as Sioux Falls," Adamson said.

Bill Adamson, center, asks a young couple if small-town amenities drew them back to South Dakota.

If educated, highly skilled workers are choosing to return to rural states like South Dakota, what's driving this decision? Certainly, it isn't wages, normally one of two major forces in migration.

Adamson and Partridge think it might be amenities, the second factor, which they intend to investigate further.

One kind of amenity is rural or "small town," and might include such factors as less congestion, a community-type environment, lower crime rate, slower pace of life, less traffic, and cleaner air. The other type is natural amenities that might include living in the mountains or beside a lake or next to a golf course.

"These are two distinct things," Adamson explained. "Some counties have rural amenities but not natural amenities. Some have both. Even some metropolitan areas have natural amenities such as a seashore–but no rural amenities."

Examination of the issue was boosted when the pair discovered an excellent source of data in the National Longitudinal Survey of Youth at the Ohio State University. Collection of the data is funded by the U.S. Department of Labor, and this particular study is longitudinal in that it tracks the migration of a sample of 12,000 people over time, starting in 1979. Tracking is specific, down to county level.

By comparing the loss of wages versus the gain in amenities, the researchers hope to demonstrate just how much income people are willing to give up in order to have a higher quality of life.

Some answers already are in hand.

"Clearly, amenities play a more significant role in urban-to-rural migration. The likelihood of such migration is higher among persons with advanced degrees and those in managerial and professional and technical work. This is somewhat surprising, because this type of worker loses a higher percentage of his income when moving to a rural state like ours," Adamson said.

"We also know that the regions with the highest probability of urban-to-rural migration include the Midwest, West, and South," he added.

The implications of these findings to a state as agricultural as South Dakota?

"Well, I think it is going to tell us the direction that economic growth is going to go," Adamson said. "It will reveal what will be the best way to enhance growth.

"Agriculture, of course, is the major industry in a state like South Dakota, but the trend in agriculture is for farms to get bigger and bigger. And that means there will be less employment in agriculture. Typically, where there is heavy dependence on agriculture and mining there is out-migration because there are greater job opportunities in other areas that are not as agriculture- or mining-intensive."

Finding the industries that offer employment to new residents will reveal the growth potential in nonagricultural segments of South Dakota's economy.

"We already know that service jobs are increasing, but these are mostly low-wage jobs. So, there must be other growth areas in the higher wage jobs that are attracting these folks from urban areas to our state.

"For now, our main focus is to try to measure the market value of amenities. The reason we think we can do this is because, when we see people move from a metro to a non-metro environment, their wage rates clearly go down. They have to be getting something else to compensate for this. How much of their wages are they willing to give up to gain certain types of amenities?" ❖

Biostress challenge:
enhancing economic growth while maintaining rural quality of life

It has been a good time to own ag land. How long will it last?

Year's jump in land values highest of the 90s

by Jaimi Reimer

Buying land has turned out to be one of the best investment options of the 90s.

Since 1991, South Dakota agricultural land values have increased faster than the rate of general price inflation–one of three major findings from SDSU's 1998 South Dakota Farm Real Estate Survey.

Over the past 6 years, average state agricultural land values increased 43%, compared to the inflation rate of 18.2%.

"For anybody who has owned land during this period of time, it's been a very good inflation hedge," said Larry Janssen, economics professor at SDSU.

The 1997-to-1998 annual change in agricultural land values was 10%. "This increase is the highest we've seen for the 1990s," remarked Burton Pflueger, Extension farm financial management specialist and survey co-investigator.

At 53%, rangeland values increased at an even greater percentage rate than cropland values at 39% during the 6-year period. Cropland and forage land values increased at similar rates.

The dramatic increase in rangeland values is due to outside investors.

"The native range or lower quality areas that are classified in the survey as rangeland have had a high demand put on them for recreational use, particularly for hunting," said Pflueger.

"There's a number of people buying land as an investment and for recreational uses; they don't intend to farm it themselves. That's a change from what it was 10 years ago," added Janssen.

The economy has been a boost for the land market. "From 1995 to 1997, we had years of good (commodity) prices and interest rates that were steady to lower. That combination fueled a lot of optimism in the land market," said Janssen.

Favorable financial situations also account for increasing land values.

"The financial circumstances have been considerably better in the 1990s than they were back in the 1980s when everybody borrowed money with very low down payments to buy land," commented Janssen. "When the export market turned adverse and lenders wouldn't refinance, the land market came to a screeching halt."

Beryle Sessions, Brookings County assessor, and Larry Janssen consult a county map.

The 262 respondents to this year's survey also listed interest in farm expansion and financial strength of owners as reasons for increasing land values.

Another key finding of the survey revealed South Dakota's agricultural land values vary by region and land use. In each of the eight regions, per-acre values were highest for irrigated land, followed by nonirrigated cropland, hayland or tame pasture, and native rangeland. For each land use, per-acre land values are highest in the southeast and lowest in western South Dakota.

The state average value of nonirrigated agricultural land, as of February 1, 1998, was $319 per acre. Nonirrigated regional average ag land values varied from a high of $766 per acre in the southeast to a low of $115 per acre in the northwest.

Average nonirrigated cropland values ran from $903 per acre in the southeast region to $434 per acre in the central region to $200 per acre in the northwest region. Average cropland values exceeded $1,000 per acre in several counties of eastern South Dakota.

Average rangeland values varied from $408 per acre in the southeast to $98 per acre in the northwest. Substantial differences were found within each region in per acre value due to land productivity and land use, said Janssen.

Cash rental rates patterned after land value trends and have also increased dramatically over the past 6 years.

"The cash rental market provides important information on returns to ag land. A majority of South Dakota's farmland renters and ag landlords are involved in one or more cash leases for ag land," reported Janssen.

Cash rental rates from 1991 to 1998 increased more than 30% in the north-central, southeast, central, and northwest areas of South Dakota. Cash rental rates in the southwest, south-central, and northeast increased 16 to 20% during the same period.

"Some areas of the state have seen a 52% increase in cash rental rates, and that is causing some pressure on producers to be able to make rental payments. But the land is still being rented at those higher rates," noted Pflueger.

The strongest cash rental rate increases were for cropland. The average dollar amount of increases in cash rental rates were generally lower in the central and western regions of South Dakota.

Specifically, average cash rental rate increases from 1997 for cropland were $5.80 and $7.80 per acre in the east-central and southeast regions, respectively, while cash rental rates for hayland in these regions increased by $3.70 and $5.30 per acre, respectively.

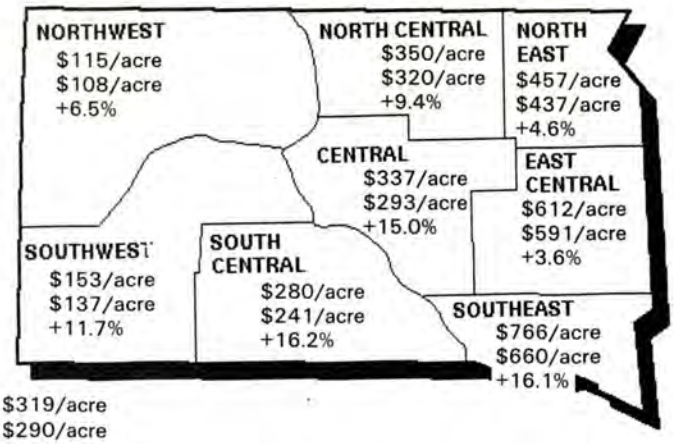
Rangeland rental rates per acre increased in most regions, while rates per Animal Unit Month (AUM) held steady or increased in all regions. The survey found average rangeland rates per AUM in 1998 varied from $16 to $19.80 per AUM in most regions.

Survey respondents credited good crop yields, federal farm programs, and Conservation Reserve Program payment rates for rent value increases.

A third key finding of the study was that the average net rate of return on ag land continues to be lower than the farm land mortgage interest rates that most producers face.

Rates of return to agricultural land this year remained slightly lower than average rates of return over the past 6 years. Respondents' estimates of net rates of return to agricultural land ownership in their localities, given current land values, were 5.1% for all agricultural land, 6% for nonirrigated cropland, and 4.4% for rangeland. These numbers compare to the farmland mortgage interest rate of 7.5% to 10%.

Average value of South Dakota agricultural land, February 1, 1998 and 1997, and percent change from one year ago.



Top: Average per-acre value—February 1, 1998
Middle: Average per-acre value—February 1, 1997
Bottom: Annual percent change in per-acre land value

"This implies that relatively large down-payment requirements are necessary before farmers can realize cash flow from net returns," said Janssen.

Janssen advocates discretion for those considering purchasing land because of the much lower commodity prices in 1998.

"There are some price events this past year that lend considerable caution to the land market, but whether or not they will affect those out there buying is uncertain."

Pflueger predicted that, "If commodity prices remain under pressure, the land market should stabilize or decline in the next several years.

"It gets to be a murky crystal ball in predicting where land values are going to head," he continued. "There still are some urban sprawl pressures and some investor interest in hunting areas, while the northeastern corner of the state could see some down-pressure on ag land prices just because they are not getting a crop."

According to Janssen, "If commodity prices remain at current levels (August 1998) for another season, cash rents and land prices should start to decline."

SDSU developed the Ag Land Market Trends Survey 8 years ago to estimate agricultural land values and cash rental rates by land use in different regions of South Dakota.

The information is intended for farmers, ranchers, landowners, agricultural professionals, and policy makers interested in agricultural land market trends. Respondents were lenders, appraisers, and Extension agents. ❖

A copy of the report may be obtained from the SDSU Department of Economics, (605)688-4855.

Biostress challenge:
predicting ag land market trends

'It's time for everybody to stand up and take responsibility for teaching values'

Building character in our most important resource

by Stephanie Misar

Scott Gardner, center, talks with high school students about the need for building interpersonal relationship skills that will serve them in the future.

South Dakotans are painfully aware that the drug culture, alcohol, and generally declining ethical values are hurting too many young people in the state. South Dakota is no longer a "safe" place to bring up children just because it's rural. Nor is "caring" without "action" enough to impart important values to young people.

South Dakota elementary and high schoolers are receiving education on ethical choices through two programs introduced with the help of faculty at SDSU. Research will follow up in the lives of some of these young people to document whether the values taught have lasting effect.

"I think that people are finally saying that for so long we have been leaving it up to the schools to teach, leaving it to the parents," says Rachelle Walsh, CharacterCounts project leader, "but now it's time for everybody to stand up and take responsibility for teaching these values. If we don't, where are we going to end up?"

The dissimilar programs, "CharacterCounts" and "Connections," come from different areas of the university but have many common goals.

The College of Family and Consumer Sciences in cooperation with the Ag Experiment Station is in the early stages of the new Connections program in South Dakota high schools.

The Connections program teaches juniors and seniors the importance of reducing stress and stabilizing the interpersonal relationship skills needed to secure a solid marriage and a sound future.

Scott Gardner and Delores Kluckman of the College of Family and Consumer Sciences are working together to get the program up and running.

Gardner says that many of the skills needed to build relationships are also those needed to build a strong career.

"When I was in Texas, I came across a study citing the top 20 concerns for a community, and 12 of the top 20 were all related to marital distress.

"We always focus on the family and environment for prevention of these problems. We need to include the educational system in preparing young people for marital relationships, which often are the root of other problems."

Fifty high schools in South Dakota are using the Connections curriculum. Pre-tests and post-tests will gauge the short-term impact of the program, and evaluations by teachers and faculty will round out the research.

In the long term, Gardner would like to conduct even later follow-up research on control test groups, to determine how the information attained in the high school classroom helps these individuals fare in their relationships and marriages long after they graduate.

"Are these people more apt to take pre-marital classes before marriage? Then, if there are problems in their marriage, do they seek counseling instead of throwing in the towel and divorcing?"

Gardner says South Dakota teachers are highly interested in a relationship-building program structured for the classroom. One example of their enthusiasm came at the Vocational Education Conference in Pierre in August, where 48 of 50 individuals participating in a Connections training session were willing to participate in the research.

"The teachers were very positive and excited to have a ready-to-go curriculum that has been used for a number of years nationally.

"In an era where our divorce rate hovers at around 50%, and when we see so many community, family, and personal problems as a result, we have to focus on prevention. Teaching this information is vital to preventing and avoiding the many problems related to marital distress, including crime, gangs, domestic violence, and suicide," Gardner said.

At the same time, 4-H leaders in the Cooperative Extension Service are surveying the effectiveness of the CharacterCounts program.

Nearly 80,000 youth in South Dakota have been reached by this program since its beginning in 1996, and 66 counties have implemented the program locally.

Evan LaMont, junior from Ellendale, N.D., and a summer 4-H assistant in the state office, helps a 4-H day camp participant in a CharacterCounts caring activity.

The CharacterCounts program is built upon ethical values called the "six pillars of character:" trustworthiness, respect, responsibility, fairness, caring, and citizenship.

The SDSU CharacterCounts task force is staffed by Walsh; Nancy Swanson, 4-H Foundation director; Bill Wright, Rural Sociology Department and CharacterCounts evaluator; and Mark Britzman, SDSU's Sioux Falls campus director.

Typically, an entire town and school district participate in a CharacterCounts program.

For example, "In Dupree, we had 69 people go through the training," Walsh said, "bringing together community members, business owners, high school teachers, and school principals from surrounding school districts."

In most cases, the trainings are spurred by general interest in the community. County Extension agents are the individuals who have pulled things together, Walsh said.

Elementary schools have started to creatively make the program their own, Walsh added.

"What is nice about the program is that you can do your own thing with it. It's not 'Here is the curriculum, set aside an hour a week and do CharacterCounts.' Teachers can use the material whenever they are teaching."

Walsh says that community members and business owners have supported the program outside of school doors.

"In Martin, the banks have started to print the 'pillar of the month' on bank statements. In Miller, the insurance companies and banks have painted the pillars onto their office windows. In Britton, the banks have displayed the pillars and ethical quotes on business signs. Some community business have even sponsored community CharacterCounts programming."

Over 5 years, students, teachers, parents and community members participating in CharacterCounts will be polled through a standardized survey. This will be matched with baseline data from 8,000 South Dakota students taken before initiation of the program.

A typical question might be, "Do you agree or disagree with 'In today's world, people often have to lie or cheat to succeed.'"

Wright says the evaluation of CharacterCounts is off to a good start. "All that remains is to carry out the next 4 years of data collection."

Communities will be kept up to date, Walsh says. "The evaluation process is important to let them know if the program is making a positive impact. The continuous feedback will assist educators and community leaders in providing the best character education possible.

"Five years from now we hope the evaluation reflects an increase in positive behaviors, such as community involvement and volunteerism, and a decrease in negative behaviors, such as cheating, lying, and stealing.

"We may think that we in South Dakota are isolated from bad things that happen, but we're not. It has been great to see how communities rally together and really work on programs that emphasize good things for our youth." ❖

Biostress challenge:
helping youth build lifelong personal ethics and values

World-class scientist's assay finds the damaged sperm that contribute to reduced fertility, abortions, birth defects

Connection: biostress and sperm damage

by Mary Brashier

The SDSU scientist is halfway around the world, working for a year in Australia. Meanwhile, the lights still burn in his biochemistry laboratory on campus.

In his absence, Danish scientists will come to learn his procedures. Their government has purchased expensive scientific equipment on the basis of his recommendations. They need to know how to use it for an assay developed at SDSU.

The research project with military recruits in the Czech Republic also continues. Data already collected will be the first-ever published report that definitively ties air pollution to human sperm damage.

Packages with French, Missouri, Argentinian, Canadian, Texas, and dozens of other postmarks keep coming, dry ice smoking around microtubes of bull and stallion sperm.

Don Evenson, Distinguished Professor of Biochemistry, can afford to spend a year in Sydney. He leaves the work at SDSU in the capable hands of Lorna Jost, his research assistant, and Kjersten Larson, Ph.D. student. "Very accomplished," Evenson described them.

But he's not abandoning them. "We run a 'virtual lab,'" he commented just days before he left campus. "Minutes after Lorna and Kjersten make a measurement in Brookings, the data can pop up on my computer screen in Sydney. We'll never be out of touch."

Evenson will be taking the sperm chromatin structure assay (SCSA) he perfected at SDSU to the Australian lab. The assay is used internationally for molecular probing of mammalian sperm viability.

In return, he will learn some sophisticated Australian techniques for *in vitro* fertilization of livestock eggs. Eventually he wants to reduce the infertility, abortions, and birth defects in livestock and humans that are caused by damaged sperm.

"It's a whole new era of assisted reproductive techniques," Evenson said. "The sperm cell was the first cell ever observed under the light microscope by van Leeuwenhoek 330 years ago. In the last 50 years, scientists have really focused on improving livestock genetics and helping infertile human couples, but they've still only been able to evaluate sperm through the same kind of microscope most of us remember from high school and college biology.

"They could count the sperm, see how lively they were, and roughly check their appearance. That's it. Their assessments had to be pretty subjective.

"Our assay is the first computerized, instrumentation-based system able to measure thousands of sperm cells in a sample in just seconds of time. We can examine the biochemistry of the nucleus of each individual cell."

The assay methodology will be added to a newly revised United Nations World Health Organization (WHO) manual, "the bible of human fertility," according to Evenson. The manual describes criteria for normal human fertility and techniques to assess fertility. It is used by scientists and physicians around the world.

"Our assay has power in numbers. It has power in precision. And recent

data indicate it has power in accuracy for predicting subfertility."

He has explained SCSA many times to dignitaries and visiting scientists but is still enthusiastic about this powerful protocol. "It's simple," he begins.

Sperm are given a half-minute exposure to acid. The acid has no effect on the DNA in a normal sperm head. But if the chromosomes are damaged, even 30 seconds of acid treatment will expose the unraveled double-stranded DNA.

Then a fluorescent dye, acridine orange (AO), is added. In the flow cytometer, the stream of sperm is passed through a blue laser light. AO-stained cells with normal DNA will emit a green fluorescence, damaged cells a red fluorescence. The machine picks up those differences and records the information in an attached computer. The assay can measure 1,024 gradations of DNA quality.

"If a human or animal sample has more than 30% red cells, we're suggesting that this donor has a high probability of being infertile," Evenson said.

But if a normal, sexually mature animal or human produces up to hundreds of millions of sperm daily, wouldn't 70% of that be adequate?

Evenson doesn't think so. "The 30% abnormals that we catch are only the tip of the iceberg. They show up only because we look for them. There are many more different environmental stresses that occur naturally and that we're not seeing."

A spell of hot weather is one of those serious environmental stresses. Evenson and his co-workers have found a high correlation between environmental heat stress and loss of sperm quality.

And they can detect that damage within 3 days following a heat spike. Classical tests do not detect damage until 10 or more days after the fact.

"Speed is a real advantage for the livestock industry," Evenson said. "It gives about a week head start over the old methods in culling poor quality semen. Artificial insemination companies won't face unhappy producers whose cows didn't get bred and there will be no need to add the expense of second attempts."

Another environmental stress is air pollution.

The Czech Republic study is the "first data documenting human environmental stress" on fertility potential, according to Evenson.

Sperm is collected from 18-year-old Czech military recruits at their induction physicals. One set of young men is from an industrial town in northern Bohemia where air pollution from the smelters is trapped in winter by atmospheric inversion layers. Age-matched recruits are from a lumbering area that has much cleaner air.

The study will additionally show variation among the men in their susceptibility to chromosome damage, Evenson expects.

In Australia, Evenson will be working with internationally known scientists, learning their techniques for microinjecting a single sperm of known DNA quality into a bovine egg.

The method sidesteps the need for a large herd of cows and bulls which would otherwise be needed to follow up on the fertility research.

"The embryo will develop in the lab. This is the most efficient way to find out if it's normal or not, or if it aborted."

A portion of the embryos will be implanted in an animal to further evaluate pregnancy outcome–birth defects and growth patterns that may reflect genetic damage to the sperm.

Don Evenson

Evenson will also speak at international conferences while in Australia. He is, in fact, booked through the year 2000 as keynote speaker in various areas of the world.

He began his research into mammalian fertility while at Sloan-Kettering Cancer Institute in New York. A Sinai, S.D., native, he wanted to come home and returned to South Dakota 15 years ago with a flow cytometer, one of the very few in this region at the time. Over the years, in addition to building an international reputation as a molecular biologist, he received more than $2 million in grants to carry on his work. Funds have come from the South Dakota Agricultural Experiment Station, USDA, EPA, the National Institutes of Health, and the

March of Dimes. Just before he left SDSU, he was awarded over a third of a million dollars from the EPA and USDA.

He remembers those first years. "When I came to SDSU, I was like 'the petunia in an onion patch,' or was it the weed among the petunias, because I had no colleagues at SDSU studying reproductive toxicology. Even now, the nature of this work has always required that we work with scientists from around the world in places where pollution effects are often greater than in the United States."

Fortunately for him, expanding technology makes that global communication easier to do each year.

"We'll keep things moving here while I'm gone, and I'll be back before you know it." ❖

Biostress challenge:
identifying environmental effects on human and livestock fertility

Another proof we should give pigs more credit for their 'smarts'

Pigs don't need a palace

by Larry Tennyson

One of the most costly mistakes in animal production enterprises is improper environmental management. For instance, lean-growth swine have the genetic potential to reach mature market weight in 150 days, yet the current U.S. average approaches 200 days.

"This extra time represents a tremendous facilities and efficiency cost for swine producers," according to Steve Pohl, SDSU ag engineer. "It also reduces profits and wastes fossil fuels.

"What we have shown is that pigs are extremely adaptable. If they have good genetics and have good nutrition, they don't need an out-standing barn. There are advantages to maintaining a certain set temperature, but pigs apparently can stand some variability in temperature and still do quite well.

"A producer could spend a modest amount to get the most important improvements made on his barn, and the pig will do the rest."

Pohl and collaborators Dr. Larry Turner of the University of Kentucky and Dr. Jack Nienaber of the Meat Animal Research Center at Clay Center, Nebr., came to that conclusion after analyzing data that looked at one of those major environmental

factors: temperatures within the facility.

"Swine in the growing and finishing stages of production can be subjected to a wide range of temperature conditions that depend on weather, the type and condition of the swine facility, and how well the environmental control system is designed and managed," Pohl explained.

"In a lot of cases, the high cost of new facilities, the lack of financing, and the availability of older existing buildings have forced producers to use less desirable buildings to grow and finish swine."

The concern was about high lean pigs. Would adverse conditions like these be counter-productive economically and result in poor pig performance?

One study that monitored swine performance and physiological responses resulted in the "NCPIG" model that approached pig growth and heat production by simulating growth and metabolic processes, Pohl explained.

"One of its objectives was to be able to predict the responses of growing swine in various feeding and environmental conditions. What it didn't do was to take into consideration certain characteristics of the facility itself."

Pohl and his fellow researchers developed questions they wanted to answer: What happens when pigs in varying pen sizes are placed in hot or cold environments, what micro-environments exist at these times, and what are the implications of these findings on the NCPIG model?

With $10,000 in funding from the South Dakota Pork Producers, Pohl set up the study in April 1997 in the newly remodeled swine growing and finishing facility at the Southeast Experiment Farm near Beresford. Bob Thaler, Extension swine specialist, and Brad Rops, Southeast Farm research technician, assisted with the project until it concluded in March 1998.

Using swine groups of 1, 9, and 18 pigs per pen, Pohl and his associates performed three summertime tests at temperatures of 90 degrees and 70-90 degrees Fahrenheit and three wintertime tests at 50 and at 70 degrees to see what effect group size had on performance. All swine were acclimated at 70 degrees for 7 days, then put on test for 28 days. Pigs had high lean genetics and weighed an average 60 pounds at the start and an average 110 pounds each at the end of the test.

Average daily gain, feed intake, feed efficiency, and backfat were measured. Records also were kept for temperature, relative humidity, water usage, and floor and exterior wall temperatures. The dimensions of the various pens were adjusted to give each animal the same number of square feet for the 9- and 18-pig pens.

The model ordinarily would predict that the higher the average daily temperatures, the lower the daily gain.

Preliminary analysis of the data shows the pigs gained slightly faster than the NCPIG model would predict, and they ate slightly less of their ration. This, in turn, produced a higher feed efficiency figure.

The model apparently overestimates the impact of 90-degree temperatures, Pohl said. "This was caused by an underestimation of feed intake.

"The model also didn't take into consideration the adaptability of the pigs. The pigs in our study stayed well apart from one another, drank large quantities of water, and stayed close to the cooler parts of the facility floor."

Although the model underestimated the amount of feed the pigs would be eating, it did do a fairly good job of predicting average daily gain.

"We thought by cooling off those rooms, we'd affect performance in a very negative way–but we didn't get it," Pohl explained. "The effect of cool temperatures on performance maybe has been overestimated, although it's risky to generalize too much on the basis of this one study."

What happened is due again to the adaptability of the pig. When the temperatures were lowered, the pigs huddled together and thus modified their environment, Pohl said.

"It was the same story for a single pig alone in a pen," Pohl said. "The single pigs grew more hair, ate more, and did what they could to modify their environment.

"So, given the opportunity, the pig will adapt."

The NCPIG model was based on a single pig and not a group of pigs–that's one source of possible error this study demonstrates, Pohl added. "The model does a good job under normal conditions, but not under extremes like those we introduced in this study. Models like these, in fact, almost have to be calibrated to the conditions of each individual swine operation.

"Of course, we have to be careful about generalizing about these results. This was a study with a specific kind of pig, and those with different genetics may not perform in exactly the same way under these conditions." ❖

Biostress challenge:
managing animals and their environments for maximum efficiency

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